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FARMERS' BULLETIN 406.

SOIL CONSERVATION.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
OFFICE OF THE CHIEF,

Washington, D. C., May 2, 1910.

Sir: I have the honor to transmit herewith a manuscript entitled *Soil Conservation*, by Prof. W. J. Spillman, Agriculturist in Charge of the Office of Farm Management, Bureau of Plant Industry, and recommend that it be published as a Farmers' Bulletin.

Our soils are by far the most important national resources. In this bulletin Professor Spillman makes clear the situation that confronts us in view of the fact that practically all the more desirable farm land in the country has been brought under cultivation; and that to meet the increasing demands for food stuffs, improved methods of farming must be used. Such methods must be employed as are best adapted to the conservation and maintenance of soil fertility. To these ends there are discussed some of the more important factors determining the improved methods of farm management that must soon be generally adopted.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SOIL CONSERVATION.

INTRODUCTION.

How to restore and maintain the productivity of the soil is the most important phase of the conservation problem. We are no longer a new nation. We have deluded ourselves with the idea that we have unbounded resources in land, in forests, in mineral wealth. We have been prodigal in the utilization of these resources. We must now pay the penalty of this prodigality. In many of our older communities soil fertility has been reduced below the point of profitable production. Nation-wide effort at the present time, through federal and state agency, is directed toward the restoration of fertility in these localities. On the prairies of the West fertility is beginning to wane. In order that our heritage in the prairie country may not follow the descent of the East and the South, it is necessary that intelligent and vigorous effort be made to farm correctly. We must cease abusing the soil. The renting of land on short leases for the purpose of growing grain for market is one of the surest means of reducing the productive power of the soil. The domestic animal, with well-managed pastures and rational systems of crop rotation, is preeminently adapted to the development of permanent systems of profitable farming. Landowners must realize this and must take steps to improve renting methods by stocking farms with a full complement of domestic animals, where the renter is not able to do this for himself, and by giving longer leases, whereby the renter may reap the reward of intelligent management.

DISPOSAL OF LAND BY THE GOVERNMENT.

Land owned originally by the Government has, in the main, been wisely given into the hands of millions of small owners, each of whom manages his own holdings as an independent proprietor. This method of disposing of the national domain has led to the rapid creation of well-distributed wealth. It has meant conservation by utilization on the part of a maximum number of private owners. But the very magnitude and richness of this heritage has led to such prodigality in its use that now, when the period of settlement is practically

past, we find ourselves confronted with increased demands for food, which must be met by soils that have been depleted of much of their yielding power. This is an important factor in the recent increase in the cost of food.

IMPORTANCE OF CHEAP AND ABUNDANT FOOD.

The problem of cheap and abundant food is a fundamental one in all industrial development. It was the abundance and cheapness of food that made possible the marvelous progress witnessed in this country during the past century. During the last sixty years we have brought into cultivation the largest and richest body of agricultural land in the world. While this land was new and rich the production of abundant crops was accomplished at little expense and with little knowledge of the principles of conservation of soil fertility. This period of exploitative farming is now past. The cost of production is now enhanced by low yields, or the use of expensive methods of maintaining high yields. Whether the era of cheap and abundant food is past depends on our ability as a people to develop cheaper and better means of production than now prevail. We no longer have unlimited undeveloped agricultural resources. Future increase in production must come largely from better methods of farming. Whether we, as a nation, shall attain these improved methods after a long period of depression, accompanied by slow adjustment to new conditions, as has been the case in older countries, or whether we shall attack the problem resolutely and intelligently and adopt improved methods as soon as the situation demands, depends on the efficiency of those agencies that in recent years have been built up in this country with a view to meeting the problems of soil conservation and agricultural readjustment.

STEPS IN AGRICULTURAL DEVELOPMENT.

In order clearly to comprehend our present position, it is necessary to review briefly the logical steps in agricultural development. In the settlement of a new region the pioneer farmer brings with him seeds of those crops he cultivated in his former home and the live stock he deems necessary in his new situation. In a few years he has learned which of these crops are best adapted to the new environment of soil, climate, and market facilities. Then follows the rapid development of a type of farming based on one or two crops for which there is a cash market.^a The new soil is rich, and for one or two

^a In regions where transportation facilities are not favorable some form of live-stock farming is usually followed until transportation lines are open, but in new regions the manure from the stock is ordinarily not made use of, so that the keeping of the live stock is of no importance from the standpoint of the maintenance of soil fertility. Where transportation facilities are available, the development of an exploitative type of grain farming is coincident with settlement.

generations is believed to be inexhaustible. It is therefore exploited of its fertility and a general change of system is instituted only when waning yields begin to bring failure to the less progressive element in the community. When this period is reached a new problem arises. Single-crop farming requires little capital. A dwelling, a few work stock and a modest shelter for them, a little fencing, and a moderate equipment of farm implements represent the necessary capital of the grain farmer in addition to his investment in land, and the last has usually been a gift from a generous nation.

DIFFICULTIES IN CHANGING TYPES OF FARMING.

To change to a more conservative type of farming requires large expenditures for new equipment. Money must be invested in live stock, new buildings must be erected, fences built where none were needed before, and new types of machinery must be bought. Recent studies by this Department indicate that on well-organized stock farms in the Middle West the amount invested in farm buildings, exclusive of the farm dwelling, amounts on the average to \$9.27 per acre for the whole farm, while the cost of fences represents \$4.60 per acre. These two items alone, therefore, represent an outlay of about \$2,220 on a 160-acre farm. The major part of this expenditure must be met when the farm changes from grain growing to stock farming. The investment in live stock itself on such a farm represents another sum nearly as large as the above. In addition, more labor is required, and this labor must be more intelligent and more reliable. Hence the change from an exploitative to a conservative type of farming is at best a gradual one, and requires unusual resourcefulness on the part of the farming population.

EXPLOITIVE FARMING TOO LONG CONTINUED.

It is not strange, therefore, that in many communities exploitative farming continues beyond its legitimate life. In fact, such a change could hardly proceed in the older settled States while the unbounded West offered the renter and the farm laborer the opportunity to acquire a home by gift from the Government, on soil fertile enough to permit, for one or two generations, profitable farming with little equipment other than energy and courage. At the same time, the nation as a whole did not suffer from the depletion of the soil in the older States, for the reason that increased production on the rich soils newly brought under cultivation in the West kept pace with the ever increasing demand for food. Hence it was that the decrease in the agricultural population and the abandonment of a large part of the land formerly tilled in the Eastern States attracted little attention.

Agricultural economists looked with complaisance on the decrease in rural population, shown in the following statistics taken from recent census reports:

DECREASE IN POPULATION AND ABANDONMENT OF LAND IN THE OLDER STATES.

Gain or loss in population, 1890-1900.

State.	Rural (loss).	Urban (gain).
	Per cent.	Per cent.
Maine.....	8.46	40
New Hampshire.....	8.28	49
Vermont.....	12.30	59
Connecticut.....	12.30	60
New York.....	11.30	35
New Jersey.....	11.90	58.5
Delaware.....	8.13	20.4
Ohio.....	4.55	30.8

* Inhabitants not living in incorporated towns or cities.

Similarly, a decrease of 38.1 per cent in the area of improved farm land in the six New England States between 1880 and 1900 was not regarded as a calamity, but as a natural consequence of the opening up of richer and more easily tilled lands in the West, and the development of transportation facilities between the grain fields of the West and the cities of the East. In many of the older States a similar abandonment of land has occurred that is not shown by statistics. In most of these States the area of improved land is only 25 per cent to 40 per cent of the total area. New land has been cleared as old land was abandoned. A conservative system of agriculture would have kept the older lands in cultivation.

THE PRESENT SITUATION.

We are now confronted by a new situation. The bringing into cultivation of new land in the West no longer meets the loss due to abandonment of older lands in the East, combined with the increased demand for farm products. Our people, instead of remaining at home and building up impoverished farms, still continue to migrate in search of virgin lands. The stream of migration which has flowed westward since settlement began on the Atlantic coast is now being deflected southward and northward. During the past six years an average of 54,000 American citizens have annually crossed over into Canada in the hope of finding new land that would bring rich returns from exploitative farming. A countercurrent of migration is even setting in from the West toward the East. A good many western farmers are selling their lands at high prices and moving to the cheaper lands on the Atlantic seaboard. Tension is felt on all sides. The exhaustion of free lands has increased the price of land all over the country. The rising price of land makes it more difficult for the young man with

slender capital to acquire a home on the land; hence there is an increase in tenant farming. The situation is intensified by the prevailing unsatisfactory system of renting land. Leases are usually made for short terms. The renter has no interest in maintaining the fertility, for he has no assurance that he will receive the benefit of it. He is interested only in immediate results. He therefore proceeds to rob the soil by exploitative methods of farming similar to those which prevailed when the land was first put into cultivation. As an indication of the prevalence of short-term leases an illustration may be taken from a single county in the State of Ohio. An enterprising newspaper published in this county makes a specialty of securing data concerning the number of tenants moving from one farm to another. In the spring of 1909 the announcement of such removals occupied a full page of very condensed reading matter in this newspaper. The paper states that it is the custom in the county for renters to remain only one year on the farm. Continuation of this custom means the ultimate ruin of both land owner and renter.

From what has been stated above it is not surprising that the values of farm products have risen to a marked degree in the past few years. This has affected other industries. City people are beginning to turn toward the land. This department receives many hundreds of letters annually from people employed in manufacturing, mercantile, and transportation industries asking for information that will enable them to become farmers.

Not only has the value of farm products increased, but exports, especially of breadstuffs, have fallen off in a marked degree. Comparing the five-year period ending in 1903 with that ending in 1908, the exports of corn and its products decreased from 135 million bushels to 82 million bushels, a decrease of 39 per cent. During the same time the exports of wheat decreased from 212 million to 114 million bushels, a decrease of 46 per cent. If America is to retain the favorable balance of trade which has characterized the past quarter of a century, it must be done not by increase in acreage, as in the past, but by increase in yields per acre. We no longer have unlimited areas of virgin soil to exploit. The question whether we shall be able to meet the increased demands for food and clothing by increasing the yields is a pertinent one. In this connection the following statistics are of interest:

CONDITIONS IN OLDER COUNTRIES.

Average yields, 1901 to 1905, inclusive, in bushels per acre.

Crop.	Germany.	France.	Great Britain.	Belgium.	United States.
Wheat.....	28.2	20.2	31.7	34	18.8
Rye	24.9	16.8	34	14.8
Barley	34.3	24.0	34.3	46.5	27.0
Oats	41.1	32.0	44.7	64.7	30.9
Corn.....	24.9

These figures show that in the older countries of Europe, where farming has been followed for many centuries, the problem of satisfactory yields of farm crops has been solved. The agriculture of Germany is more nearly similar to that of the United States than that of any other of the countries mentioned in the above table. It will be noted that the yield per acre of wheat in Germany is more than twice that in the United States; the yield of rye nearly twice as large; the yield of barley nearly a third larger; and the yield of oats more than one-third larger. It will be interesting to know how the German farmer maintains these yields. The following statistics give us some information on this point:

Comparative area of different classes of crops in Germany and the United States.

Classes of crops.	Germany.	United States.
	Per cent.	Per cent.
Cereals.....	52.0	64.0
Hay and forage.....	31.4	21.3
Roots.....	13.8	1.3
Fibers.....	.8	9.1
Vegetables and fruits.....	2.0	3.3
Miscellaneous.....		1.1

* Permanent pasture lands not included, as this item is not available for the United States.

It will be noticed that the proportionate area of cereals grown in Germany is about one-fifth less than in the United States, while the proportionate area of hay and forage crops is one-half greater. In addition to that the percentage of the total area which is planted to root crops is enormously greater in Germany than in the United States. These root crops consist largely of potatoes and sugar beets, and the best German authorities estimate that at least one-third of the products of the area of these two crops is available for stock feed. They also estimate that one-third of the products of the area devoted to cereals is devoted to the feeding of domestic animals. Germany, therefore, devotes very much more of her soil to the production of feed for live stock than does the United States.

The larger proportion of land devoted to raising feed for live stock permits more stock to be kept, as shown in the following figures:

Numbers of the principal kinds of live stock maintained per 100 acres of land on farms in Germany and the United States.

Live stock.	United States.	Germany.	Difference.
			Per cent.
Cattle.....	16.3	29.1	78
Horses.....	4.4	6.4	45
Swine.....	15.1	25.8	71
Sheep and goats.....	15.3	19.9	30

Thus, on the same area of farm land, the German farmer maintains on the average from 30 to 78 per cent more live stock than does the American farmer. The manure from these animals is also better cared for in all European countries than it is in this country. Not only that, the United States exports vast quantities of cotton-seed meal, linseed-oil meal, and other rich nitrogenous feeding stuffs, while Germany imports vast quantities of these materials. German farmers not only conserve their own natural resources but they draw on other parts of the world to maintain the fertility of their lands. America has been mining her soil and shipping the products to Europe. In addition to the sources of fertility above given, Germany uses annually on her soil 550,000 tons of nitrate of soda, 275,000 tons of sulphate of ammonia, 1,200,000 tons of superphosphate, and 1,400,000 tons of basic slag, in addition to large amounts of potash salts.

Conditions similar to those in Germany are found in England, Belgium, and France. The farmers of these countries, by necessity, have worked out the problem of profitable conservative farming, and especially have they learned the value of domestic animals as a means of conserving fertility. We are now confronted by the same necessities that compelled the adoption of sound systems of agriculture in the Old World. How shall we meet this problem?

THE SOLUTION OF THE PROBLEM.

In the first place, we must increase the number of domestic animals on our farms. Where land is farmed by renters the leases must be made for longer terms, and where the renter has not the capital to provide the proper number of domestic animals these must be supplied by the landowner. We must give more attention to the condition of our pastures. In some parts of this country pastures have been overgrazed until they are nearly worthless. This is especially true in some regions where dairy farming is prominent. Cows are turned on to pastures too early, and the grass is given no chance to make the necessary growth to maintain vitality. Pastures which formerly supported one animal on 2 acres now support only one on 10 acres. This is not universally true, but it is true in large areas. The ranges of the West have been depleted by overpasturing, and in addition are now being settled by farmers, so that the range area is decreasing. There is a serious shortage of live stock in that section, and this shortage must be met by raising more young stock on the farms of the East.

EFFECT OF LIVE STOCK ON SOIL FERTILITY.

The effect of live stock on the fertility of the soil needs no demonstration. It is well known to every intelligent farmer. Up to the present time, at least, no system of agriculture has been permanently

profitable without the use of domestic animals as a means of maintaining the productiveness of the soil. Whether such systems are possible remains to be seen. It may be that the use of legumes and other crops producing humus, combined with the judicious use of commercial fertilizers, may serve to maintain high yields, but the supply of commercial fertilizers is not unlimited, and ultimately these soil amendments will have to be dispensed with.

EFFECT OF LEGUMES.

In addition to increasing the number of domestic animals on American farms our farmers must pay more attention to leguminous crops and to other crops which provide a supply of humus for the soil. Legumes, such as clover, peas, alfalfa, etc., are especially important because of the fact that with the aid of certain soil bacteria they are able to draw their supply of nitrogen from the air. Having thus an unlimited supply of this valuable plant-food constituent, they become very rich in nitrogen. The stubble and roots of a leguminous crop frequently leave in the soil sufficient nitrogen for the needs of the crop that follows. Recent investigations by this Department in Kansas and Nebraska show that the average increase in the yield of corn grown after alfalfa, compared with corn grown after nonleguminous crops, is 75 per cent. A good crop of clover has a similar effect on the yield of crops which follow it. Instances are known where the practice of sowing bur clover in cotton fields in the fall of the year and turning it under in spring in time for another crop of cotton has, in three years, doubled the yield of cotton. Crimson clover sown in a similar manner between crops of corn has, in a few years, increased the yield of corn 50 per cent or more.

The reason these leguminous crops have such a marked effect on fertility in many cases on depleted soils lies in the fact that nitrogen is not a constituent of the soil proper, but only of the decaying plant and animal matter in the soil. When soils are farmed for many years without any attention to their fertility this organic matter is rotted out and the nitrogen disappears. Hence nitrogen is nearly always the first plant-food constituent to become deficient in the soil.

The fact has already been referred to that we export a large proportion of our cotton-seed meal, oil meal, and other rich nitrogenous feeding stuffs. In 1908 we exported linseed-oil meal to the amount of 696 million pounds, cotton-seed meal 929 million pounds, and corn-oil cake 66 million pounds. These materials are all exceedingly rich in nitrogen. They should be kept at home, fed to live stock, and the manure returned to the land.

DEPENDENCE ON OUR OWN RESOURCES.

There is this difference between our situation and that of the older countries of Europe: Hitherto we have been exporters of our feed stuffs rich in fertilizer constituents, while they have been importers. They have been drawing on the newly settled regions of the world for materials with which to feed their crops. Now that we have reached the period where we need to do the same thing, there are no great areas of virgin soil from which we can draw such supplies. Indeed, it seems that the countries of Europe will not always be able to draw on supplies of this character from other parts of the world, because they will soon be needed in the regions where they are produced. The American farmer can therefore not hope, at least in the near future, to import feeding stuffs with a view to enriching his land, but he will be making a long step forward when he quits exporting these materials and returns them to his own soil. Whatever shortages there may be must be made up by the intelligent use of commercial fertilizers. There is no danger of a nitrogen famine. We can grow leguminous crops to supply nitrogen. We can also, by judicious use of the refuse from grain and other crops and by the use of intelligently planned crop rotations with occasional catch crops for green manure, keep up an abundant supply of humus. Even if we had no other resources for maintaining the fertility of the soil than leguminous plants and humus-making crops we could, on much of the land in this country, maintain a much higher standard of yields than obtains at the present time.

EXAMPLES OF SUCCESSFUL FARMING.

Many examples could be given of remarkable results accomplished on American farms by the introduction of improved methods of soil management. A few instances will suffice. In New York State there are large areas of lands which formerly produced satisfactory crops, but which in recent years have been reduced in fertility to the point where their cultivation is no longer profitable by the methods in vogue in that section. Two years ago a representative of this Department induced a farmer in that section to grow 4 acres of potatoes under his direction. This farmer had been growing potatoes for many years, using seed which had been grown for sixty years in that locality without selection to maintain its quality. His ordinary yields of potatoes were about 40 bushels per acre. He was induced to secure new and improved seed and to cultivate in the most thorough manner. As a result, these 4 acres produced a yield of 250 bushels of potatoes.

per acre. Similar results have since been secured by a number of other farmers in the same locality.

An Illinois farmer a good many years ago established on his farm a rotation of corn, corn, oats, clover. The corn and oats were fed to hogs, which were allowed to graze on the clover. Very little feed was purchased, but everything raised on the farm was converted into manure and returned to the land. At the beginning of this system of farming the yield of corn was about 35 bushels to the acre. Ten years later it had risen to 80 bushels per acre, the average yield for four consecutive years being 80.4 bushels per acre.

A Missouri farm, which had been devoted to corn and wheat for seventy years, and on which the yields of wheat were about 8 bushels per acre and corn about 25 bushels, was subjected to a system of farming similar to that just described for an Illinois farm. In six years the yields of this farm were more than doubled.

The work of the Farmers' Cooperative Demonstration Office of this Department shows that by the utilization of resources at the command of every farmer enormous increases can be made in the yield of crops. In this work the following points are emphasized:

1. Deep fall preparation of the soil.
2. Planting of well-selected seed.
3. Mainly shallow and frequent cultivation of the crop during the growing season and especially after a rain.
4. The judicious use of commercial fertilizers and the increased use of home-produced fertilizers and the growing of leguminous crops.

During the year 1909, 509 farmers in the State of Alabama, working under the direction of representatives of this Department, raised 1,235 demonstration acres of corn. The average yield was $33\frac{1}{2}$ bushels per acre, while the average yield for the State, as shown by the figures of the Bureau of Statistics of this Department, was $13\frac{1}{2}$ bushels.

In the State of South Carolina 658 farmers grew 2,718 acres of cotton in the demonstration plats. The average yield was 1,205 pounds of seed cotton per acre. In the same State 537 farmers grew 1,636 acres of corn in the demonstration plats. The average yield was 36.1 bushels per acre, compared with an average yield for the whole State of 16.7 bushels.

In both these States the yield of corn on the demonstration plats is seen to have been more than twice the average yield for the State. The average yield of cotton for the State of South Carolina for 1909 is not available, but it is certain that the yield of cotton on the demonstration plats is at least 50 per cent greater than the average for the State. These yields were made by methods which any farmer in the South can use.

CONCLUSION.

These facts show that the main work to be done for soil conservation in this country is that of teaching the farmer how to utilize the resources at his command. The methods to be pursued are, in the main, understood by leading agriculturists and progressive farmers all over the country, but they are not understood by the great majority of farmers. The latter must be taught by precept and example. It will take time to bring about the necessary change.

The methods necessary in bringing about these changes are, first, to determine what types of farming are best adapted to the conditions prevailing in the different sections of the country, and, second, to help the farming population to readjust itself to these conditions. This readjustment is an expensive process to the farmer—new equipment must be earned and more labor must become available. Not only must the farmer be taught the principles of soil management, but he must be taught how to take better care of his animals and how to breed a better class of animals. National and state agencies are now cooperating in this work of teaching the farmer improved methods.

Present conditions in America are merely an incident in the development of a new agricultural region. Now that the period of settlement and exploitation of the soil is passed, we are under the necessity of developing systems of farming suited to the individual soils in order to develop their highest efficiency and to make the most of their fertility. Where the last has been impaired, the systems must be adjusted to obtain the restoration of the highest possible productivity under economic limitations, while keeping in view the best uses of the soil when the fertility has again reached its maximum. In this readjustment we shall have to draw on the results of scientific investigation and on the experience of older nations. Many of our own farmers have successfully met these great problems, and their experience now becomes a source of valuable information to others. Fortunately our people are intelligent and aggressive, and there is every reason to believe that they are capable of meeting the emergency which now confronts us.

[A list giving the titles of all Farmers' Bulletins available for distribution will be sent free upon application to any Member of Congress or the Secretary of Agriculture.]